Achieving Efficiencies in D&D Work through Technology Deployments

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ABSTRACT
In the Accelerated Site Technology Deployment (ASTD) Integrated Decontamination and Decommissioning (ID&D) project, three Department of Energy (DOE) sites teamed to deploy nine innovative but proven technologies during Decontamination and Decommissioning (D&D) Operations. The goal of the project was to promote wide acceptance and use of the technologies among D&D personnel in order to achieve improved safety and greater efficiencies in D&D work. Selection and procurement of the twelve technologies was based on their previous success in DOE technology demonstrations in the areas of cost, schedule, radiation exposure, waste volume, and overall safety and a match with identified needs. In addition, technologies that were most likely to provide significant cost savings for a small investment were chosen. Since the technologies were previously shown to perform better than baseline technologies, the ASTD ID&D project was chartered to focus on deploying them in numerous areas, while collecting a

minimal amount of data to document their impact. Innovative approaches to cost estimating and data collection were required to document the benefits of the new technologies while meeting the project budget. For instance, rather than recording the number of cuts made with the oxy-gasoline torch, the fuel consumption was tracked and used to estimate the amount of cutting and resultant cost savings. Using this type of approach to collect data, cost savings were estimated $462K at the Idaho National Engineering and Environmental Laboratory (INEEL), $201K at Fernald Environmental Management Project (FEMP), with significant but difficult to quantify savings at Argonne National Laboratory East (ANL-E), for a project total of $663K during FY98 and FY99. At the INEEL, deploying the seven ASTD ID&D technologies is projected to save about $14M over the next ten years. Early teamwork with D&D Operations resulted in the selection of technologies that meet current needs. This match, combined with the improved performance of the technologies, led D&D workers to deploy the technologies in numerous additional areas on their own initiative, leading to the technologies quickly becoming the new baselines.

PROJECT STRUCTURE

The overall goal of the ASTD ID&D project was to promote wide acceptance and use of innovative but proven technologies to improve safety and reduce costs of D&D operations. Funding and guidance from the National Energy Technology Laboratory (NETL) through the ASTD Program enabled these deployments, and was key to the success of the project. The project was a team effort among ANL-E, FEMP, and the INEEL.

TECHNOLOGY SELECTION

Before the technology selection process began, the selection team carefully considered how to choose technologies that would result in successful deployments. Several guidelines were developed. The new technologies should:

1. Perform significantly better than the baseline technologies.
2. Be proven in the Large Scale Demonstration and Deployment Project (LSDDP) or commercial use.
3. Meet identified needs in D&D Operations.
4. Show a large benefit for a small investment.
5. Be widely applicable across the DOE complex.

First, the technologies must perform significantly better than the baseline technologies. In order to quantify this, five performance areas were identified. The new technologies should perform better in terms of cost, schedule, radiation exposure, waste volume, or overall safety. Ideal technologies would out-perform the baseline technologies in more than one of these areas. Second, the technologies must be proven, either in the LSDDP, or in commercial use. While other DOE projects were chartered with investigating newly released technologies, the purpose of the ASTD ID&D project was to bring tested, innovative technologies into wider use in D&D Operations. Third, the technologies must meet identified needs in D&D Operations. Members of the D&D Operations team know most about which tools or processes need improvement. By asking for their input, the selection team is likely to choose technologies that will have a large benefit. In addition, if the D&D Operations team aids in the selection process by identifying their needs, they are more likely to be supportive and use the new technologies. And certainly, technologies that do not meet a current need won't be used. Fourth, the technologies should show a large benefit for a small up-front investment. This way, with the limited ASTD ID&D procurement budget, the team would be able to deploy numerous technologies. And fifth, the technologies should be widely applicable across the DOE complex. Many DOE sites share common needs for D&D projects. Selecting technologies that meet common needs opens the door for them to be applied at other DOE sites, yielding even greater cost savings for the DOE.

TECHNOLOGIES

Twelve technologies were selected for deployment, in tasks ranging from characterization to demolition. The deployment locations and supplier information for the technologies are given in Table 1. A brief description of each technology is given here; additional details are located on the ASTD ID&D website, at: http://id.inel.gov/idd/

Brokk BM250

The BROKK BM250 (Figure 1), developed by Holmhed Systems AB in Skelleftea, Sweden, is a remote-controlled demolition system that replaces hand-held equipment. The system is electric powered, with a variety of end effectors that can be attached to the hydraulic arm. The BROKK BM250 can be manipulated from 200 feet away using a tether remote control system, or from 400 feet using a radio remote control system. The BROKK BM250 remote demolition equipment has many advantages over hand-held tools. It allows the operator to be positioned at a safe distance from high radiation areas and other hazardous conditions, eliminates problems of exhaust fumes in containment areas, and performs work significantly faster than manual tools. The BROKK BM250 was deployed at the INEEL and at ANL-E. At ANL-E, two BROKK BM250s worked in tandem on continuous shifts to break apart the high-density concrete bio-shield of the CP-5 research reactor and to load the debris into waste containers. Because of the relatively high radiation levels around the reactor, doing the work without these machines could have resulted in large personnel dose rates. The BROKK BM250s were successful in significantly accelerating the schedule and reducing the cost of this D&D work. D&D workers at both sites like the increased safety and productivity of the Brokk BM250.

Personal Ice Cooling System (PICS)

The Personal Ice Cooling System (PICS) is a self-contained cooling system that uses ice-chilled water circulating through tubing sewn into the suit to cool workers. The PICS (Figure 2), manufactured by Delta Temax, Inc., of Canada, consists of a full body suit or a vest, a harness-mounted ice bottle, and a battery-powered pump to circulate the water. The cold water absorbs body heat, and then returns to the ice bottle to be re-chilled. The PICS, which weighs only 12 pounds, is worn under the worker's PPE and allows normal freedom of movement. PICS suits provide many advantages, including increased stay time (under Industrial Hygienist supervision), less PPE change-outs, increased worker well being and comfort, and safer body temperature. When the PICS vests were deployed at the INEEL, workers commented that the suits made a big difference and rendered immediate cooling in otherwise uncomfortable conditions. Using the PICS at the INEEL in FY99 resulted in a cost saving of about $38K.

Oxy-gasoline Torch

The Oxy-Gasoline torch (Figure 3), manufactured by Petrogen Inc., is a gasoline fueled tool for cutting carbon steel. It consists of a fuel tank with safety valves, a gasoline supply hose, and a cutting torch head. Safety was a primary consideration in the torch’s design. Since liquid gasoline cannot burn and the fuel is a liquid all the way to the cutting tip, there is no chance of backflash in the fuel line. The Oxy-Gasoline torch, which cuts faster than conventional torches, relies on 100% oxidation rather than melting to cut through the metal. Oxy-Gasoline torches were deployed at the INEEL and FEMP. At both sites, the operators liked the torches so much that they used them at different areas on their own initiative. The Oxy-Gasoline torch is fast becoming the baseline at the INEEL and FEMP for D&D metal cutting operations.

Decontamination, Decommissioning, and Remediation Optimal Planning System (DDROPS)

To efficiently cut and package contaminated waste generated from dismantling a facility, engineers and programmers at the INEEL have developed a special computer interface known as the Decontamination, Decommissioning, and Remediation Optimal Planning System (DDROPS). DDROPS (Figure 4) provides an optimized size reduction and packaging plan for tanks, piping, and other dismantled equipment. A three-dimensional model of the facility is made and the optimal number and location of cuts (with respect to length, mass properties, and radiation) is determined using an optimization program. This system also shows how to package segmented items into waste containers and provides a detailed inventory of the waste box contents. DDROPS helps train operators by providing a preview of the job, minimizing the cuts made and reducing time spent in the contaminated area. It also results in improved packing densities, less waste containers, and less disposal costs. The INEEL has been awarded a patent on the DDROPS system. The DDROPS was used to optimize segmentation of process piping and packaging of waste into the Low Level Waste (LLW) containers at the INEEL Sewage Treatment Plant. Using the DDROPS projections, about 1.6 waste boxes would have been required to hold the material. Using standard methods, six boxes were actually used to hold this waste. This shows the tremendous potential for waste volume reduction through the use of the DDROPS.

GammaCam™

The GammaCam™ (Figure 5), manufactured by AIL Systems, Inc., provides qualitative information (i.e., graphical information showing radioactive hot spots, but not field strength or isotope identity) about radioactively contaminated areas. Because this is done remotely, exposures to workers are reduced. The GammaCam™ identifies primary sources of radiation by providing a two-dimensional color image of gamma radiation fields placed over a corresponding visual black and white video image of the area being scanned. The GammaCam™ was used several times during 1999 to survey contaminated areas at the INEEL Test Area North Hot Shop.

Modular Scaffolding System

The Automatic Locking Scaffold System (Figure 6), manufactured by Excel Modular Scaffold and Leasing Corporation, was designed for speedy assembly and disassembly. It uses vertical frames with support cups and interlocking horizontal bearers, which snap onto the cups by means of spring-loaded, positive locking trigger mechanisms. Excel Modular Scaffolding has been used during D&D of three INEEL facilities. The D&D carpenters commented that it is much easier and faster to install than tube and clamp scaffolding. In fact, one deployment was initiated and carried out entirely by workers because they had seen the positive implications of using the new scaffolding at other locations.

Soft-Sided Waste Containers

Transport Plastics, Inc. has developed a Low Level Waste Packaging System known as Lift-Liner™ bags (Figure 7) for safe storage and transport of contaminated materials. These flexible waste containers are larger in size and weight capacity than the solid metal or wood baseline containers. Their flexibility minimizes void spaces, saving both container and disposal costs. The bags are made of woven and coated 25-mil (0.025-inch) polypropylene and are lined with two layers of 40-mil (0.040-inch) high-density polyethylene. They cost about half as much and hold about three times as much as the baseline containers. In addition, their large size means that they hold larger debris, so less waste processing is necessary. Soft-sided containers have been deployed at four INEEL locations. Users have been so impressed with the Lift-Liner™ bags that they have become the baseline technology for low-level waste disposal at the INEEL.

<u>Portable Concrete Crusher</u>

D&D often results in large amounts of concrete debris and facility sub-structure areas that need to be backfilled. Crushing the concrete debris and re-using it as backfill material would save the cost of hauling and disposing of the debris, as well as the cost of hauling in clean fill material. Excel Recycling and Manufacturing, of Amarillo, Texas, has developed a concrete crushing system that is well suited for this type of work. The Excel 2522 Low-Pro Concrete Crusher (Figure 8) is a 51-foot portable plant, including conveyors, feeder, crusher, screen, engine, chassis, and trailer. Large pieces of concrete, including reinforcing steel, are loaded into the crusher, where they are thrown against blow bars and rubblized into pieces about one to two inches in diameter. A powerful rotary electromagnet separates the reinforcing steel (rebar) from the concrete debris and conveys it to a separate pile. Due to budget constraints within D&D Operations, deployment of the concrete crusher at the INEEL was delayed until FY00.

<u>Hand-Held Shear</u>

The Res-Q-Tek hand-held shears (Figure 9) operate from a hydraulic source, and reduce airborne contamination during cutting operations. In addition, the shears provide a crimping effect on process piping, which helps control the spread of contamination from within the pipe.

The hand-held shears were deployed at FEMP to segment small diameter (3 inch or less) piping and conduit in several facilities. Operators liked the ability to quickly segment conduit in tight areas next to walls, components and other obstructions.

Track-Mounted Shear

The track-mounted shear is a large cab-operated demolition machine. Because of the length of the shear arm, it can be operated at a distance from the work surface. This removes operators from the immediate demolition area, allowing the work to be completed more safely and efficiently than baseline methods. The shear used at FEMP consisted of a John Deere 450 LC track-mounted excavator with a Pemberton PES-II 700R shear. FEMP used the track-mounted shear during D&D of seven facilities. The long reach of the shear allowed the operator to remain safely out of harm's way during operation. The field manager and the operator of the track-mounted shear commented on how easily, safely, and efficiently the shear was able to segment, remove and place heavy steel members and elements directly into waste containers.

COST BENEFIT ANALYSIS CALCULATIONS

The goal of the ASTD ID&D project was to deploy many technologies and document their impact, but not to collect detailed performance data. To do this, the team needed to develop ways to collect data and measure the benefits of the technologies with a minimum amount of data collection. Using the detailed performance data from the LSDDP was a key part of the ASTD ID&D cost benefit analyses. Using this data, the ASTD ID&D was able to identify key factors that could be used to measure the cost savings from using the new technologies, and collect data only in these areas. For example, rather than track how many cuts were made, or the hours of use with the Oxy-gasoline torch, the team monitored the volume of gasoline consumed during cutting operations. Using data from the LSDDP, this was correlated to the amount of cutting done, and the resulting cost savings. In another case, rather than measuring the set-up times for the Excel Modular Scaffolding, the ASTD ID&D team measured the volume of area within the scaffolding, and used the volumes and detailed set-up times from the LSDDP to estimate the set-up times for the deployment sites. Innovative methods like these allowed the project to document the benefits of using the new technologies while collecting a minimal amount of performance data. This approach led to numerous deployments with overview documentation of their impact.

Using this approach, results of deploying nine technologies at numerous locations during FY-98 and FY-99 were documented. The deployments resulted in significant cost reductions, saving an estimated $462K at the INEEL, $201K at FEMP, and significant but difficult to quantify savings at ANL-E, for a project total of $663K. Other benefits such as increased safety, reduced waste volume, and reduced radiation exposure were also noted.

In addition to the cost information, subjective data about how the technologies performed was also collected from the people using these technologies. These comments were very important, because if the site operations workers did not like the technologies, their use would not continue. By soliciting their feedback, the deployment team was also able to correct any start-up or training issues, and to act as a liaison with the technology supplier to answer questions. In all cases, the workers' feedback was very positive, and they preferred the new technologies over the old baseline methods.

PROJECTED TEN YEAR COST SAVINGS AT THE INEEL

At the INEEL, an estimate of the projected cost savings from using the seven ASTD ID&D technologies over the next ten years was calculated. This estimate was based on the INEEL ten-year plan, and was completed in the following way. First, the D&D Operations portion of the INEEL ten-year plan was separated into physical work and other tasks. INEEL D&D Operations plans to spend about $55M on physical work over the next ten years. Then we estimated how much of this physical work could be done by each technology. For example, it was assumed that the Excel Modular scaffolding would be used on 3.5% of the physical work done, or $55M X 0.035 = $1,939K. So the Excel Modular Scaffolding could be applied to work that would cost $1,939 using the baseline technology. Since the Excel scaffolding showed a 34.6% cost savings over the baseline in FY99, it is projected that the $1,939K cost using the baseline technology would be reduced by $672K. ($1,939 X .346 = $672K).

Excel Modular Scaffolding Example Calculation:

INEEL D&D Operations Physical work = $ 55 M

$ 55 M X .035 =- $1,939K

$1,939K X .346 = $672K

Approaches like this were used for each technology to estimate the projected savings over the next ten years. INEEL D&D Project Managers and Site Operations personnel provided input and validation of the estimates of how much each technology could be applied to the overall physical work. With this approach, using the seven ASTD ID&D technologies over the next ten years at the INEEL is projected to save $ 14.1M (Table 3). The D&D Operations team has accepted the new technologies as the new baseline, and has already adjusted their ten-year plan budgets to include use of the new technologies as the baseline method.

D&D OPERATIONS TEAM INVOLVEMENT

Communication with the D&D Operations team was key to the success of this project. Early in the project, the D&D Operations team assisted by identifying their needs and helping select the technologies. In this way, the technologies were sure to solve existing D&D problems and be more readily accepted by the D&D team. Later, ownership of the technologies was transferred to the D&D Operations group. This allowed them to assume responsibility for maintenance and use of the technologies. As a result, in several cases, the D&D Operations team modified the technologies slightly to meet application specific needs, giving them a greater sense of ownership. For example, they purchased a different end effector for the Brokk BM250 demolition equipment, and designed improved carts for rugged terrain for the Oxy-gasoline torches. Because the technologies themselves were so successful, and because communication and teamwork with the D&D Operations team led to a sense of ownership, the D&D team went on to identify additional deployment sites and use the technologies on their own initiative, making them the new baselines.

CONCLUSION

During the ID&D project, nine proven but innovative technologies were deployed during D&D activities at three DOE sites, resulting in significant cost savings and improved safety. Careful selection of the technologies and close teamwork with the D&D Operations team were key elements in the success of this project. Technologies with proven performance that was significantly better than the baseline technologies and a large benefit for a small up-front investment were chosen. Early input from the D&D Operations team ensured that the new technologies met their needs, and would be readily accepted by the D&D workers. Transferring responsibility for the technologies to the D&D Operations team led to a sense of ownership, improvements to the technologies, and subsequent deployments.

Because most of the selected technologies had been demonstrated and proven in the LSDDP, detailed performance data existed. This data was leveraged by the ASTD ID&D project to develop valid cost benefit analyses with a minimal amount of data collection. This approach allowed the project team to deploy many technologies at numerous locations, meeting the overall project goal of promoting wide acceptance and use of these technologies in D&D Operations.

During FY99, seven technologies were deployed at numerous locations at the INEEL, three technologies were deployed at FEMP, and one was deployed at ANL-E to perform a significant task on the CP-5 reactor. At FEMP, during FY98 and FY99, the deployments led to demolition and removal of nine structures. As a result of the ASTD ID&D technology deployments in FY98 and FY99, the INEEL saved \$462K and FEMP saved \$201K, for a project total of \$663K. At the INEEL, the ten year projected cost savings from the ASTD ID&D technologies is about \$ 14.1M.

Table 1. ASTD ID&D selected technologies.

Technology	***Function***	***Deployment Site***	***Deployment Facility(ies)***	***Supplier***
BROKK BM 250	Remote controlled demolition equipment	INEEL ANL-E	STF CP-5 Bioshield	BROKK North American Sales, 144 Village Way, Monroe, WA 98272 Bill Barraugh, 800.621.7856, 360.794.1277, porbb@aol.com
Personal Ice Cooling System (PICS)	Light weight self-contained individual cooling of workers	INEEL	TAN PREPP	Delta Temax Inc., 320 Boundary Road, Pembroke, Ontario, Canada, K8A 6W5 Kirk Dobbs, 613.735.3996
Oxy-Gasoline Torch	Fast and inexpensive cutting of carbon steel	FEMP INEEL	38A, 38B, 24B, 3F, 3G, 39C, 22A, 45B, 8F STP, STF, IET, ARA-1	Petrogen, 103 Doolittle Drive, Suite 18, San Leandro, CA 94577 Milt Heft, 510.569-7877 www.petrogen.com
DDROPS	Optimization of cutting and waste box packing of debris	INEEL	STP, ARMF/CRFMF	INEEL, P.O. Box 1625, MS 3710, Idaho Falls, ID 83415-3710 Dick Meservey, 208.526.1834 rhm@inel.gov
GammaCam™	Thorough and documented remote radiation survey	INEEL	TAN Hot Shop U.S.S.Nimitz	AIL Systems, 455 Commack Road, Deer Park, NY 11729 Al Henneborn, 800.944.1180
Excel Modular Scaffolding	Scaffolding approved by OSHA; designed for fast assembly & disassembly	INEEL	STP STF TAN PREPP	Excel Modular Scaffold and Leasing Corp., P.O. Box 1800 60 Industrial Park Road, Plymouth, MA 02360, James E Elkins, 800.625-7712
Lift-Liner™ Soft-Sided Waste Containers	Improved disposal containers for low-level waste	INEEL	STP STF ARA-1 NRF	Transport Plastics, Inc., P.O. Box 12, Sweetwater, TN, 37874 Al Beale, 800.603.8277
Excel Portable Concrete Crusher	Concrete recycling system for more efficient disposal of rubble from demolition	INEEL	STF	Excel Machinery, LTD., P.O. Box 31118, Amarillo, TX 79120 Jerry Richardson, 800.858.4002
Track-Mounted Shear	Mobile demolition	FEMP	38A, 38B, 24B, 3F, 3G, 8F	John Deere, Pemberton & Tiger Machinery Co., Inc., 11441 Mosteller Rd., Cincinnati, OH 45241 J.W. Kaperling, 513.772.3232, or Marty Prochaska, FEMP, 513.648.4089
Hand-Held Shear	Self-powered shear for tight locations	FEMP	38A, 38B, 24B, 3F, 3G	Res-Q-Tek, 10405 G Baur Blvd, St. Louis, MO 63132 Andy Dzuryachko, 314.692.0065

Table 2. Summary of ASTD ID&D cost savings at the INEEL and FEMP.

Technology	Baseline Cost	Innovative Cost	Savings
INEEL			
Brokk BM250	$75,418	$8560	$66,858
PICS – Cool Suit	$98,885	$60,557	$38,328
Oxy-Gasoline Torch *(varies depending on assumptions)*	$4000	$2137	$1863
Modular Scaffolding	$5500	$3549	$1951
Soft-Sided Waste Containers	$510,000	$157,000	$353,000
INEEL Subtotal	$693,803	$231,803	$462,000
FEMP			
Track Mounted Shear and Hand-held shear	$553,404	$352,016	$201,388
ASTD FY98 and FY99 Project Totals	$1,247,207	$583,819	$663,388

DDROPS, Gamma Cam and Concrete Crusher not included in savings.

Table 3. Projected cost savings at the INEEL over the net ten years.